



DEFTAR

Networks • Communications

DEFTR Broadband Ethernet Frequency Translator Technical Description

Digital Equipment Corporation

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DEFTR TECHNICAL DESCRIPTION

PREFACE

This technical description is for the person who has had some training in Ethernet devices and who wants a functional level description of the DEFTR frequency translator. It is recommended that this technical description be used with the *DEFTR Broadband Ethernet Frequency Translator Owner's Manual* (EK-FRETR-OM).

DEFTR TECHNICAL DESCRIPTION

RELATED DOCUMENTS

Title	Document Number
<i>DECOM Broadband Ethernet Transceiver Owner's Manual</i>	EK-OOBET-OM
<i>DECOM Broadband Ethernet Transceiver Technical Manual</i>	EK-OOBET-TM
<i>Broadband Ethernet Channel Specification and Certification Guide</i>	EK-00BEC-SM
<i>DEFTR Broadband Ethernet Frequency Translator Owner's Manual</i>	EK-FRETR-OM

CHAPTER

1

DEFTR TECHNICAL DESCRIPTION

1.0 TECHNICAL DESCRIPTION

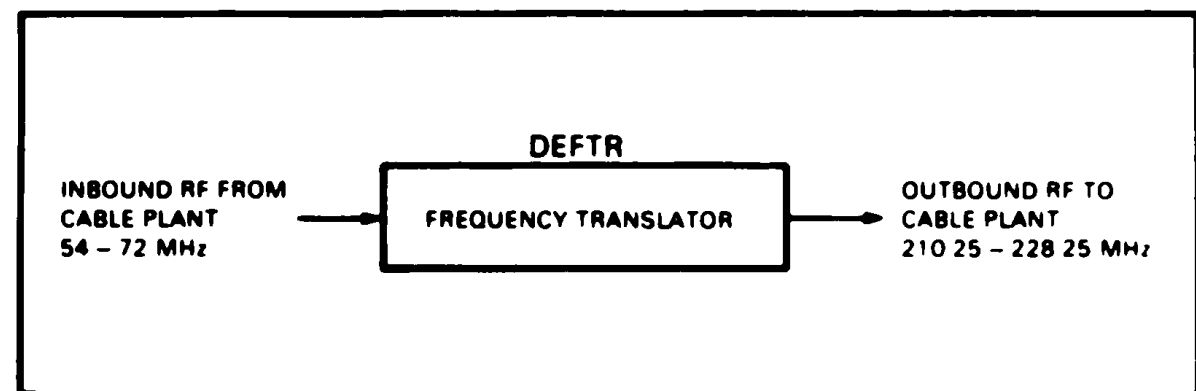
1.1 General

The DEFTR broadband frequency translator is used in conjunction with the DIGITAL broadband Ethernet transceiver (DECOM) to create an Ethernet channel in single-cable broadband networks.

The frequency translator receives the signals transmitted by the transceivers on the reverse broadband Ethernet channel, translates the signals to a higher frequency (Figure 1-1) while transposing them, and retransmits the signals to the transceivers on the forward broadband Ethernet channel.

Test points in the frequency translator allow external monitoring of the incoming data bursts, the local oscillator output, and the outgoing data bursts.

A fourth connector serves as a transceiver test port for testing DECOM transceivers.



MXV85 2055

Figure 1-1 Frequency Translator Diagram

DEFTR TECHNICAL DESCRIPTION

1.2 Transmission Path

The signal entering the frequency translator passes through a directional coupler (DC1). A portion of the signal is fed directly to the input monitor on the front panel (Figure 1-2). The through portion of the input signal is applied to an input attenuator (AT1) and a bandpass filter (FL1), which define the translatable frequencies of the input signal. The input signal then passes through another directional coupler (DC2). The output of the directional coupler is fed to the first RF amplifier (A1), which sets the noise figure of the translator.

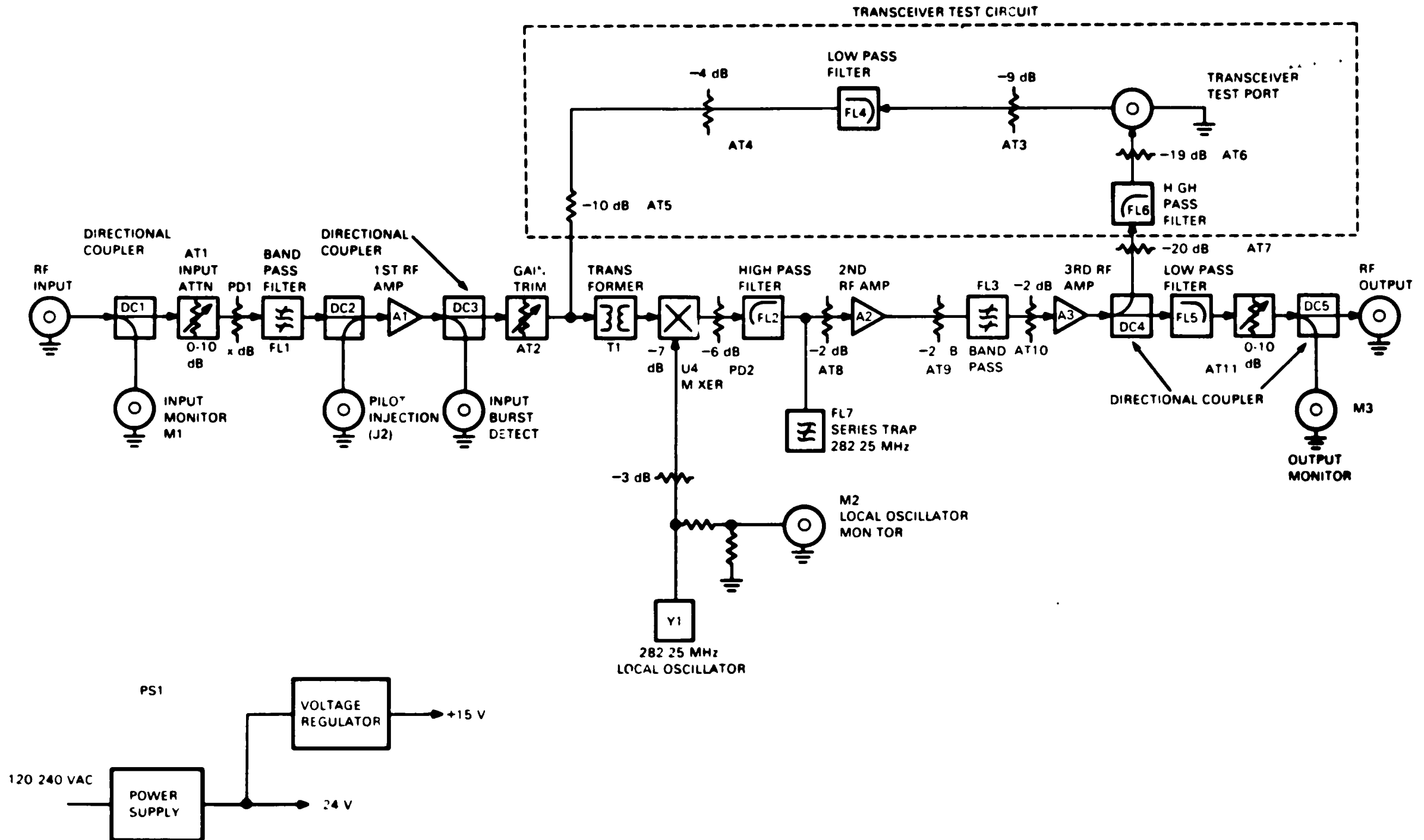
The signal is fed through another directional coupler (DC3) where a portion of the signal is diverted to the input burst detect monitor. The signal is then fed through a gain trimming circuit (AT2) and an impedance transformer (T1) to the 50 ohm mixer (U4). The incoming 61 MHz signal and the output of the local oscillator circuit (Y1) are combined in a double-balanced mixer to produce a 221.25 MHz output signal. The output of the mixer is attenuated by PD2, high-pass filtered by FL2, and attenuated again by AT8.

Local oscillator leakage through the mixer is rejected by the use of a series trap (FL7) tuned to 282.25 MHz. The second RF amplifier (A2) provides gain to compensate for losses incurred in the mixer, attenuator, and transformer. The signal is then passed through a second bandpass filter (FL3) to further reject the unwanted signals.

A third amplifier (A3) provides a final 22 dB of gain in the frequency translator. A portion of the amplifier's output (about 10.5 dB down) is diverted to the transceiver test port by the directional coupler (DC4). The main signal is then passed through the output lowpass filter (FL5). This filter has a cutoff frequency at about 250 MHz and further rejects local oscillator leakage and higher order harmonics.

Finally, the signal goes through a variable attenuator (AT11) and a directional coupler (DC5) that feeds part of the signal directly to a front panel output monitor. The other portion of the signal goes to the RF output port of the frequency translator.

DEFTR TECHNICAL DESCRIPTION



MR 65 2054

Figure 1-2 Frequency Translator Functional Diagram

DEFTR TECHNICAL DESCRIPTION

1.3 Detailed Description

Input Monitor Coupler, DC1

The incoming data burst passes through a directional coupler with approximately 0.5 dB of attenuation. The main portion of the signal continues through the translation process. The signal fed through the leg of the coupler is attenuated approximately 20 dB from the input level. This signal feeds to a test connector on the front panel, labeled Input Monitor, to allow monitoring of the input signal.

Input Attenuator AT1

The input attenuator is used to adjust the signal level(s) appearing at the input of the attenuator by as much as -10 dB at the output of the attenuator. This adjustment allows the translator to be used with many cable plants, in spite of variances in absolute levels of applications from plant to plant. The noise figure is degraded by 1 dB for every 1 dB of input attenuation.

X dB Pad PD1

The X dB pad improves the input return loss and provides X dB attenuation. This pad is factory adjustable.

Input Bandpass Filter, FL1

FL1 defines the limits of the input signal being fed to the input burst detector and the mixer, therefore, it limits the band that is translated. FL1 is the main filter in the translator, and is just wide enough to pass the data and the collision enforcement bands of the incoming signal. The insertion loss of the filter is less than 4.0 dB everywhere within the 0.4 dB passband (56-66 MHz). The attenuation relative to that insertion loss is defined in Figure 1-3. The ultimate rejection is at least 40 dB and the rejection band extends to 200 MHz. The group delay response of the input bandpass filter is shown in Figure 1-4. The input and output impedances of the filter are 75 ohms. The input and output voltage standing wave ratios (VSWRs) are better than 1.5:1 (14 dB return loss).

Directional Coupler, DC2

A small portion of the incoming signal (about 20 dB below the input level) will be used for pilot injection input (J2). In the present configuration, the pilot injection port will not be used.

First RF Amplifier A1

The first RF amplifier provides sufficient gain to set the noise figure for the translator. The RF amplifier is a wideband, RF, linear, hybrid amplifier using push-pull circuitry to achieve low distortion, gain stability, and a high (third order) intercept point. The amplifier's gain is 34 dB and both its input and output impedances are 75 ohms. The input and output VSWRs are better than 1.2:1, assuring a stable impedance to the surrounding circuitry. The RF amplifier has a noise figure of 3.5 dB and an output (third order) intercept point of +38 dBm.

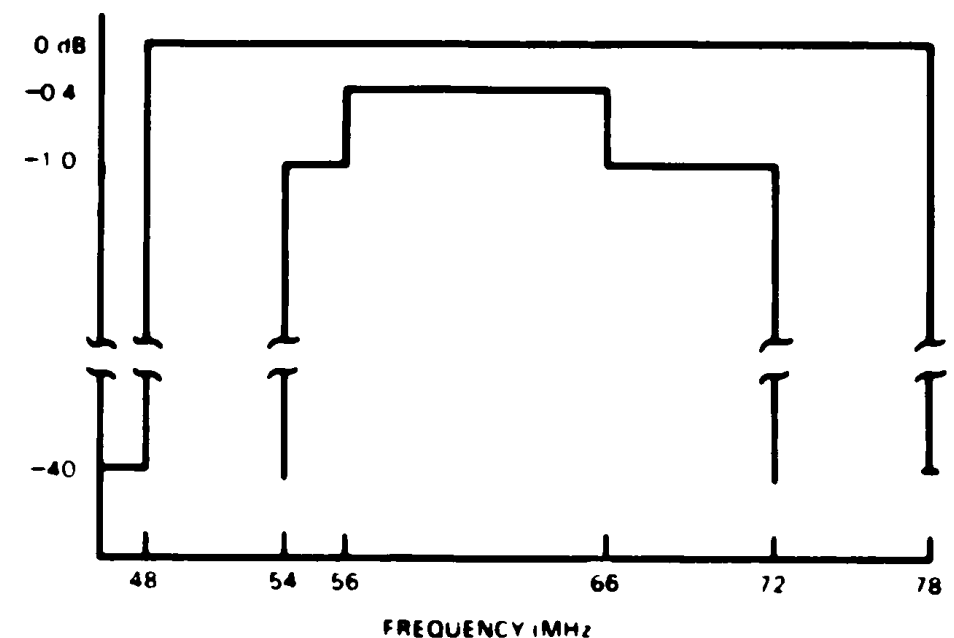
Gain Trim Circuit AT2

AT2 is a constant impedance variable attenuator used as an internal adjustment allowing for manufacturing tolerances in the gain of the various devices. The gain trim circuit assures that the total gain of the translator, from input to output, is 56 dB.

Impedance Transformer T1

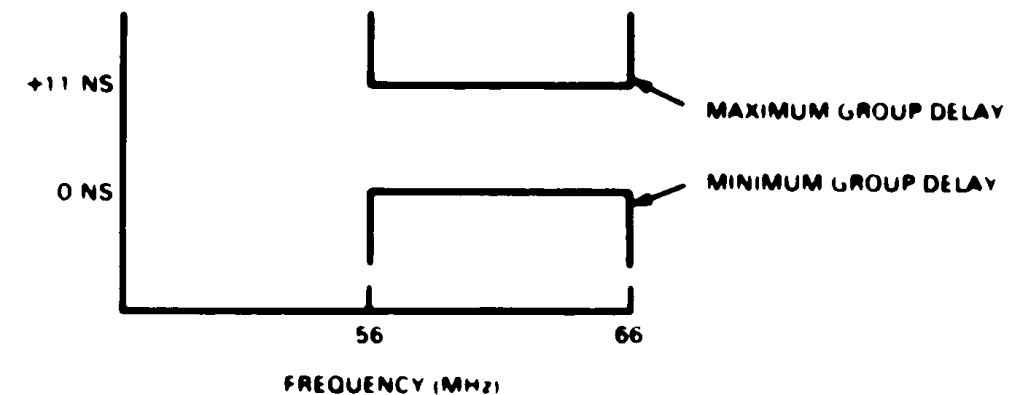
The impedance transformer provides a 50 ohm impedance for the input to the mixer, U4.

DEFTR TECHNICAL DESCRIPTION



MK VBS 2057

Figure 1-3 Amplitude Response of the Input Bandpass Filter



MK VBS 2061

Figure 1-4 Group Delay Response of the Input Bandpass Filter

DEFTR TECHNICAL DESCRIPTION

Mixer U4

The incoming phase modulated 61 MHz signal and the output of the local oscillator circuit (at 282.25 MHz) are combined in a double-balanced mixer, U4. The mixer uses high-side rejection to convert the signal to 221.25 MHz. This process causes a spectral inversion. (See Figure 1-5.) The collision enforcement signal is fed from the high side of the band to the low side of the band.

Local Oscillator Y1

The local oscillator provides a 282.250 MHz signal with a level of 10 dBm by using a crystal oscillator at 141.125 MHz and a doubler. The local oscillator output is attenuated by 3 dB to drive the mixer at +7 dBm. A small portion of the signal is used for local oscillator monitoring.

Transceiver Test Circuit

The off-line transceiver test circuit allows a frequency translator to be used to test the transmit and receive capabilities of an off-line transceiver (DECOM). See Figure 1-2. The data packets from the transceiver are first attenuated by AT3, low-pass filtered by FL4, attenuated again by AT4 to the proper level, and are then fed into the transmission path of the frequency translator just before the double-balanced mixer, U4. A small portion of the third RF amplifier (A3) output power is then diverted to the transceiver test connector by the directional coupler, DC4. The coupled output is attenuated by AT7, high-pass filtered by FL6, and attenuated again by AT6. This prevents the input signal at the test port (at +50 dBmV) from traveling down the high pass filter leg and appearing at the output of the frequency translator.

6 dB Pad PD2

The 6 dB pad transforms the impedance from 50 ohms to 75 ohms, matching the output impedance of the mixer to the input impedance of the high pass filter. The pad has a loss of about 6 dB.

High Pass Filter FL2

The high pass filter prevents the 61 MHz input of the mixer from leaking to the output of the translator.

Series Trap FL7

A series trap follows the high pass filter, and is tuned to the local oscillator frequency of 282.25 MHz. The series trap rejects the local oscillator leakage by an additional 15 dB. The signal is attenuated 2 dB by AT8 before it is passed through the second amplifier.

Second RF Amplifier, A2

The second RF amplifier amplifies the signal after the mixer and the attenuators to maintain the low noise figure achieved by the first amplifier. The second RF amplifier is a linear hybrid amplifier, which uses push-pull circuitry for low distortion and high (third order) intercept. The amplifier's gain is 34 dB and the input and output impedances are 75 ohms. The second RF amplifier's noise figure is 3.5 dB.

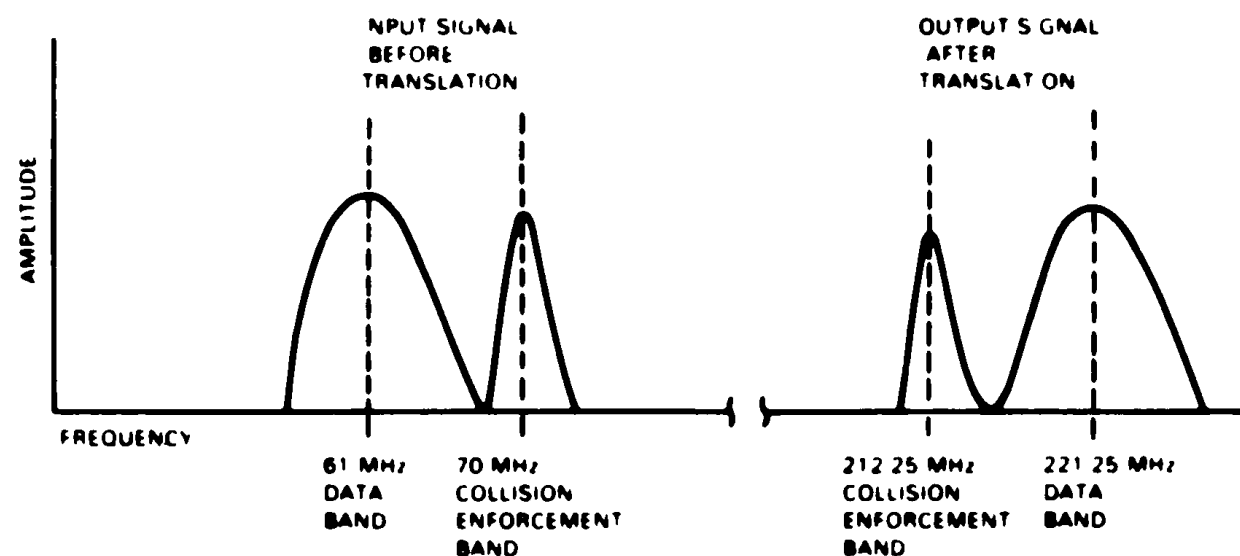
DEFTR TECHNICAL DESCRIPTION

Bandpass Filter, FL3

The second bandpass filter provides additional rejection of the unwanted by-products of the mixing process. There is about 2 dB insertion loss everywhere within the 0.1 dB bandpass. The attenuation relative to the insertion loss is defined in Figure 1-6. There is 40 dB rejection out of band and 55 dB rejection at 282.25 MHz. The group delay of the filter is shown in Figure 1-7. The input and output impedances of the filter are 75 ohms. The return loss is better than 14 dB through the bandpass.

Third RF Amplifier A3

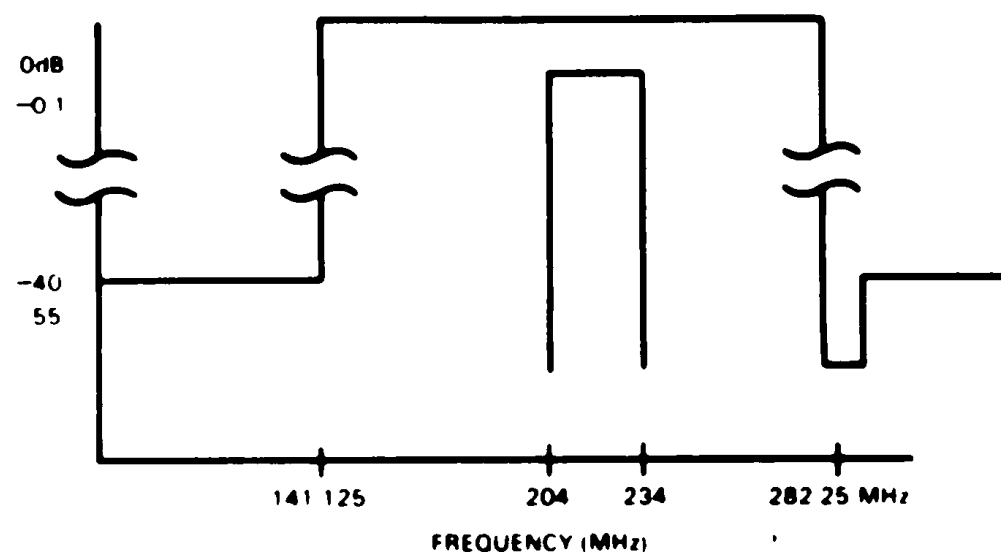
The third RF amplifier provides the final 22 dB of gain in the translation path. The amplifier also determines the third order intermodulation products at high output levels. The noise figure is 5 dB and the output intercept point is +48 dB.



MMVBS 2052

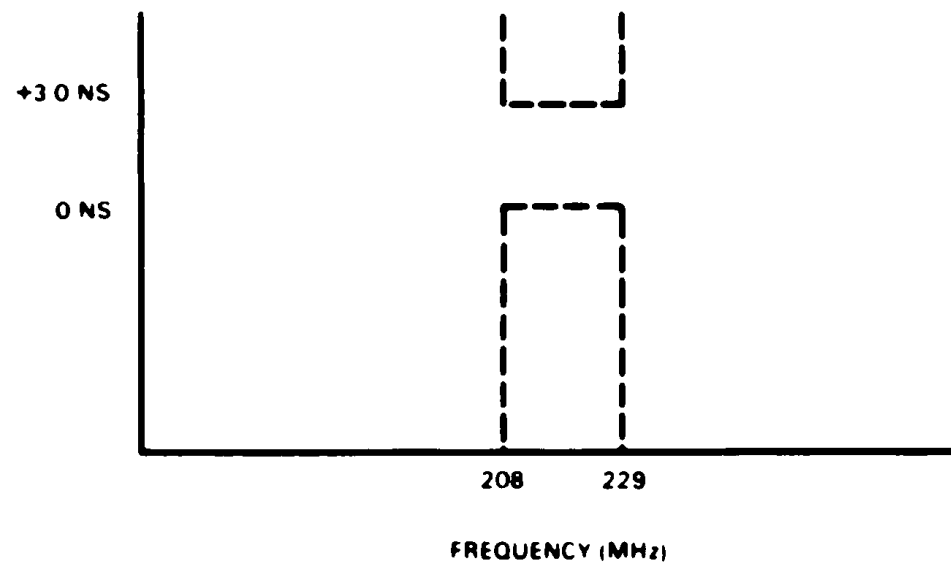
Figure 1-5 Spectral Inversion of Input/Output Signals

DEFTR TECHNICAL DESCRIPTION



MX VBS 2053

Figure 1-6 Amplitude Response of the Output Bandpass Filter



MX VBS 2058

Figure 1-7 Group Delay Response of the Output Bandpass Filter

DEFTR TECHNICAL DESCRIPTION

Transceiver Test Output Coupler, DC4

A small portion of the third RF amplifier, A3, output power, approximately 10 dB down, is diverted to the transceiver test connector by the directional coupler, DC 4. The through loss of the coupler is less than 0.5 dB. The diverted signal is attenuated by AT7, high pass filtered by FL6, and attenuated again by AT6. This provides reverse isolation at 61 MHz, preventing the input signal at the transceiver test port (at 50 dBmV) from appearing at the output of the translator by bypassing the translation process and propagating down the high pass filter path.

Output Lowpass Filter FL5

The output lowpass filter has a cutoff frequency of about 250 MHz and provides high order harmonic rejection at 330 to 355 MHz. The input and output impedances of the filter are 75 ohms. There is about 2 dB of loss in DC 4 and the output lowpass filter.

Output Attenuator AT11

The final level of the translator is set by adjusting the output attenuator from 0 to 10 dB. The adjustable attenuator matches the output level of the translator to the signal level required by the applications in accordance with cable plant loss.

NOTE

Proper attenuator settings are determined by using the path losses obtained in the Ethernet channel certification process.

Output Monitor Coupler DC5

The directional coupler provides a signal, attenuated by 20 dB, to the test connector on the front panel. The signal provides monitoring of the RF output signal. The through loss of the coupler is less than 0.5 dB.

Monitors

Three monitor points are provided on the front panel:

- Input monitor, M1
- Local oscillator monitor, M2
- Output monitor, M3

The input monitor provides a test signal 20 dB below the input level (before the input attenuator). A portion of the local oscillator output, 20 dB below that provided to the mixer input, is provided at the local oscillator monitor. The output monitor provides a place (after the output attenuator) to sample the output signal at 20 dB below the output level.

Power Supply, PS1

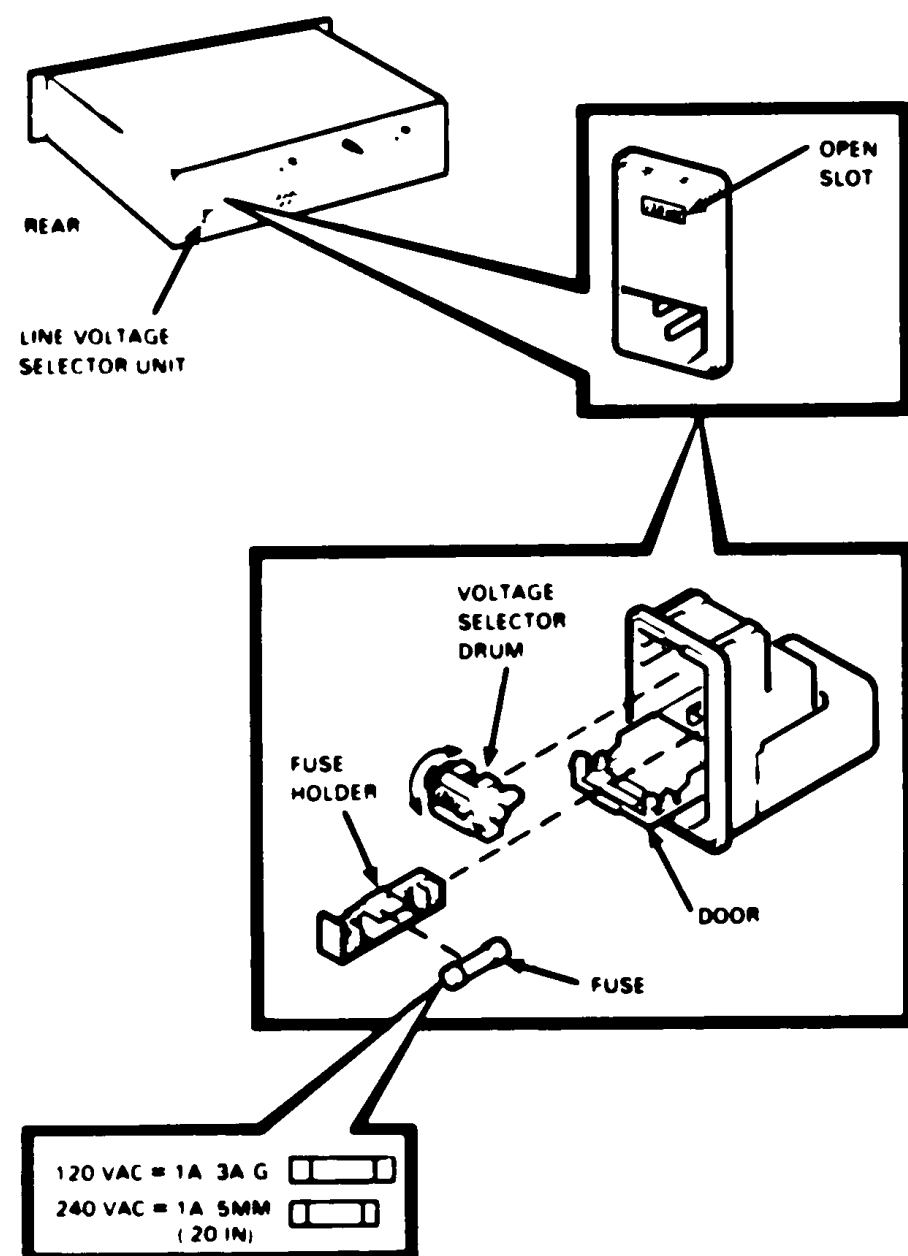
The power supply input is switch selectable between a nominal 120 Vac and 240 Vac (See Figure 1-8). The power supply has outputs of +24 Vdc unregulated and +15 Vdc regulated. Power supply filters prevent spurious signals from entering or leaving the translator on the ac power line.

A front panel LED indicates when power is applied to the translator. There is no power switch on the translator, thus, power is applied when the unit is plugged in (See Figure 1-9).

DEFTR TECHNICAL DESCRIPTION

CAUTION

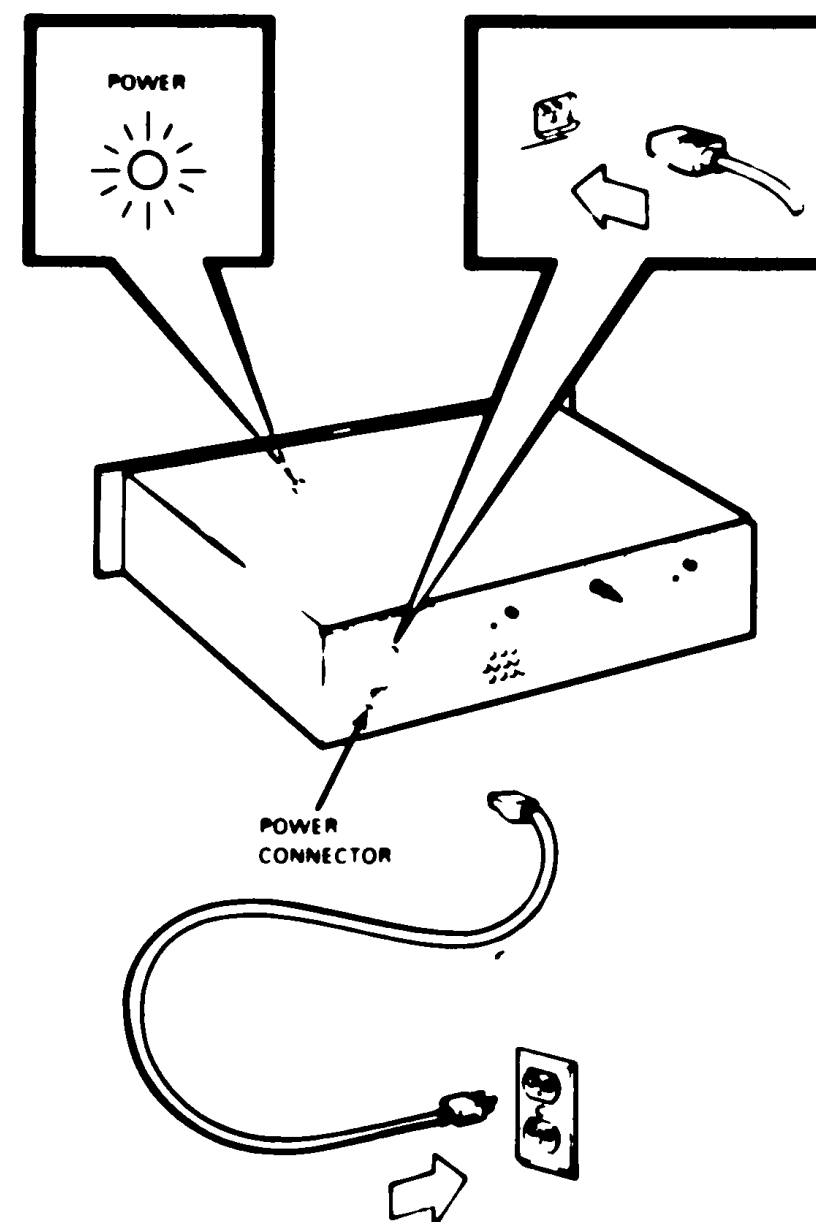
INCORRECT VOLTAGE SELECTION CAN DAMAGE UNIT



MKV85-1164

Figure 1-8 Power Supply Voltage Selection

DEFTR TECHNICAL DESCRIPTION



MKV85-1165

Figure 1-9 Power Application

CHAPTER

2

DEFTR TECHNICAL DESCRIPTION

2.0 DEFTR SPECIFICATIONS

OVERALL SIZE 133.4 cm (52.5 in) X 48.26 cm (19.00 in) standard rack mountable

WEIGHT 9.07 kg (20.00 lb)

WIDTH 43.18 cm (17.00 in) - excluding front panel

HEIGHT 13.33 cm (5.25 in)

DEPTH 38.43 cm (15.13 in)

CONNECTORS

- **Front Panel**
Input monitor = type F
Output monitor = type F
Transceiver test connector = type F
Local oscillator monitor = type F
- **Rear Panel**
RF input = type F
RF output = type F
AC power in = IEC

ENVIRONMENTAL

- **Operating Range** 5 to 40°C (41 to 104°F)
- **Storage Range** -20 to 70°C (-4 to 158°F)

LEVELS

NOTE

See Section 3.0 for Ethernet channel levels.

- **Input** 0 dBmV + 5 dB (after input attenuator)
- **Output** +56 dBmV nominal

DEFTR TECHNICAL DESCRIPTION

FREQUENCY RESPONSE AT INPUT

- 10 dB 56 to 70 MHz, minimum
- 15 dB 54 to 72 MHz, minimum

GROUP DELAY VARIATION 20 ns peak-to-peak, from 56 to 66 MHz

TRANSLATION FREQUENCY 156.25 MHz (local oscillator at 282.25 MHz $\pm$.005% over temperature, voltage, and aging ranges)

NOISE FIGURE Less than 8 dB at maximum gain Degradation of less than 1 dB per 1 dB of attenuation

GAIN 56 dB $\pm$ 1 dB, 15 to 32°C

56 dB $\pm$ 2 dB, 10 to 40°C

RETURN LOSS

- Input At least 12 dB from 56 to 66 MHz
- Output At least 14 dB from 209 to 230 MHz

ABSOLUTE DELAY 500 ns, maximum

TRANSCIVER TEST CONNECTOR

- Input +50 dBmV nominal
- Output +6 dBmV nominal

AC INPUT POWER

- DEFTR-AA 120 Vac, 60 Hz, 0.29 A, 35 W
- DEFTR-AB 240 Vac, 50 Hz, 0.15 A, 35 W

FUSE 1 A, 250 Vac, fast-blow

CHAPTER

3

DEFTR TECHNICAL DESCRIPTION

3.0 BROADBAND ETHERNET CHANNEL SPECIFICATION

3.1 Single Cable

SIGNAL LEVELS

- DECOM Transmit Level 50 dBmV + 2 dB
- DECOM Receive Level 6 dBmV + 9 dB
- DEFTR Input Level 0 dBmV + 5 dB
- DEFTR Input Attenuation 0 to 10 dB in 1 dB increments
- DEFTR Gain 56 dB + 1 dB, 15 to 32°C
56 dB ± 2 dB, 10 to 40°C
- DEFTR Output Attenuation 0 to 10 dB in 1 dB increments
- Reverse Channel Loss 37 to 53 dB with no more than 6 dB variance
- Forward Channel Loss 37 to 53 dB with no more than 6 dB variance, DEFTR at 15 to 32°C
- Total Loop Loss 44 ± 7 dB

NOISE LEVEL

Total into Receiver
(at minimum signal level) - 35.6 dBmV/4.2 MHz/BER 10⁻⁹

FREQUENCY RESPONSE (PEAK TO VALLEY)

- Reverse Channel Response Less than or equal to 1 dB
- Forward Channel Response Less than or equal to 1 dB
- Total Frequency Response Less than or equal to 2 dB

PROPAGATION DELAY

- Round Trip Delay 15.03 μs + 500 ns for the DEFTR (outlet-to-outlet)
- Outlet-to-Headend 1900 m, maximum distance
- Outlet-to-Outlet 3800 m, maximum distance

DEFTR TECHNICAL DESCRIPTION

ADJACENT CHANNEL REQUIREMENTS

Restrictions to the use of the 6 MHz (48 to 54 MHz, 72 to 78 MHz, 204.25 to 210.25 MHz, and/or 228.25 to 234.25 MHz) adjacent channels to the broadband Ethernet channel, are as follows:

- One-Way Applications

Signals less than or equal to 10 dBmV, at the outlet, are permitted to be received only in the 204.25 through 209.75 MHz bandpass and the 232.25 through 234.25 bandpass. Use the following guidelines:

- If using the 48 to 50 MHz bandpass, no use is permitted in the 228.25 to 234.25 MHz bandpass
- If using the 72.5 to 78.0 MHz bandpass, no use is permitted in the 204.25 to 210.25 MHz bandpass

- Two-Way Application

Two-way communications are not permitted in the adjacent channels.

Nonbroadband Ethernet translator skirts (40 dB points on the input filters) are permitted in the adjacent channels.

3.2 Dual Cable

SIGNAL LEVELS

- DECOM Transmit Level 50 dBmV $\pm$ 2 dB
- DECOM Receive Level 6 dBmV $\pm$ 9 dB
- Total Loop Loss 44 $\pm$ 7 dB

NOISE LEVEL

Total into Receiver (at minimum signal level) - 35.6 dBmV/4.2 MHz/BER 10⁻⁹

FREQUENCY RESPONSE (PEAK TO VALLEY)

- Reverse Channel Response Less than or equal to 1 dB
- Forward Channel Response Less than or equal to 1 dB
- Total Frequency Response Less than or equal to 2 dB

DEFTR TECHNICAL DESCRIPTION

ADJACENT CHANNEL REQUIREMENTS

Restrictions to the use of the 6 MHz (48 to 54 MHz and/or 72 to 78 MHz) adjacent channels to the broadband Ethernet channel, are as follows:

Signals less than or equal to 10 dBmV, at the outlet, are permitted to be received only in the 48.0 through 50.0 MHz bandpass and the 72.5 through 78.0 MHz bandpass.

PROPAGATION DELAY

- Round Trip Delay 15.53 μ s (outlet-to-outlet)
- Outlet-to-Headend 2000 m, maximum distance
- Outlet-to-Outlet 4000 m, maximum distance